

Beta-Eigenspaces for Autonomous Robot's Trajectory Outlier Detection

Shyba Zaheer

Department of Electrical Engineering,
College of Engineering and Applied Sciences,
Al Ghurair University, Dubai Academic City, U.A.E.
Email: shyba@agu.ac.ae

Tauseef Gulrez

Department of Computer Science,
Center for Intelligent Machines & Robotics Research,
COMSATS Institute of Information Technology, Lahore, Pakistan
Email: gtauseef@ieee.org

Abstract

This paper addresses the problem of robotics trajectory building for efficient navigation and consequently exploration. A concept of beta-eigenvector has been introduced to find an outlier for the existing non-point based trajectory obtained from raw laser data. We have used our paradigm of “free configuration eigenspaces” method, with specific focus on outlier detection. The idea is to replace the Gaussian distribution utilized by the probabilistic principal component analysis (PPCA). It is a well known issue that the conventional PCA is sensitive to anomalous observations because the calculation of sample mean and covariance matrix can be significantly influenced by a small number of outliers. Similarly, PPCA is not robust to outliers since the data are assumed to follow a multivariate gaussian distribution that is easily affected by deviant observations. An outlier detection is done using Beta-Probabilistic Principal Component Analysis, further more an analysis is proposed to identify which variables contribute the most to the occurrence of outliers. The proposed technique is applied on real-time robotics sensor data as well as on the real-time robotics simulation environment.

I. OBJECTIVE OF THE WORK

This research has following objectives:

- 1) Autonomous Robot's trajectory learning in unknown environments through non point based maps through the laser data.
- 2) Apply dimensionality reduction Technique (PCA) to compute the eigenvector in low-dimensional manifolds of laser scanning data, which corresponds to the free configuration space.
- 3) Introducing a novel Concept “Beta Eigen Spaces” to find the outliers of the trajectory using Probabilistic Principal Component Analysis (PPCA) followed under beta distribution parameters.
- 4) Also to identify which parameter contribute the most to the occurrence of the trajectory outliers.

II. SIGNIFICANCE OF RESULTS

The results are obtained from the free real-time trajectory data of autonomous mobile robot by Carnegie Mellon University, NAVLAB CMU autonomous jeep ??.

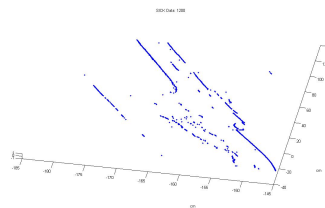
- 1) The free configuration eigen-space which can be obtained by finding an intersection between the highest eigen-vector space of sensor data .
- 2) Free-configuration space could be obtained by the pre processing of map at a given point.
- 3) The vectorial combination of all these eigen-vectors at discretetime scan-frames manifest a trajectory, and once followed and mapped onto the two control signals of mobile robot will enable it to build an efficient and accurate online environment map.

III. PAPER FITS WITH CONFERENCE THEME

This research fits with the conference theme under the “Navigation - robotics technology” section of the conference.



(a) CMU NAV LAB Autonomous Mobile Robot



(b) Map obtained from Laser data with outliers